Crinoids:
Flowers of the Iowa Seas

Grade Level 3-12

Class Periods 2

Goals/Objectives/Student Outcomes:

Students will gain awareness of:

- the continuous natural changes that have shaped Iowa's geologic landscape.
- the beauty and diversity of a group of extinct Iowa marine animals called crinoids.
- the importance contributions of professional and amateur scientists who studied Iowa rocks and fossils.

Students will be able to:

- recognize fossils and understand how they provide evidence of earlier lives and environments.
- learn about early scientific surveys of the mineral wealth of the state.
- analyze fossil evidence and compare extinct animals to modern ocean life.
- summarize the geologic history of Iowa and understand why some if it is missing.
- explain how amateur collectors could help or harm the study of Iowa's ancient life.

Materials:

1. Collections of rocks, feathers, leaves, shells, etc.
2. Iowa's state rock—the geode

Background:

When a child places a hand in wet cement an impression formed that may remain for generations. In the future others who may see the impression might learn something about the child and the activities of that day. Rocks and fossils are much like the cement and hand print of the child. They provide evidence of past life and environments. Interpreting the specimens allows a geological and zoological history of an era to be written.

This lesson plan is about Iowa's environment and how scientists observed, organized, and evaluated rock layers and fossils to develop an understanding of the past. In particular, this lesson focuses on a group of extinct Iowa marine invertebrates called crinoids. Iowa's crinoid fossils are notable because many of them have been preserved intact, which helps scientists learn a great deal about crinoids as well as Iowa's ancient seas.

We usually think of time in hours and years, generations and civilizations. Geologic time, however, covers millions of years, and must be measured by physical evidence. One important way to measure geologic time is by studying the remains of creatures that died over various eras and left behind their impressions in stone as fossils.

The geologic time table is divided into four major eras—Precambrian (which means origin of life), Paleozoic (ancient life), Mesozoic (intermediate life), and Cenozoic (recent life). Those eras are further divided into periods with characteristic fossils and rock formations.

Fossils are the remains or traces of organisms of a past geologic age buried in the earth's crust. A fossil can be a print of a leaf, the path of a worm, the shell of a marine animal, the footprint of a dinosaur, or the skeleton of a man. Remains may have been fossilized by undergoing freezing, drying, burial in tar or bogs, or by becoming carbonized or petrified. Other remains were covered in sediment that hardened. When the remains decayed, they left a cavity known as a natural mold. If this cavity is filled, duplicating the shape and surface of the fossil, it is called a cast

Early geologists in Iowa

To create economic growth for Iowa in the 19th century, it was necessary to investigate the state's soils and mineral resources for the riches they might yield. Three professional geologists were hired to produce detailed survey maps. The first was David D. Owen, employed by the U.S. government to prepare geologic reports when Iowa became a state. Later, James Hall and Charles White conducted surveys for the state government. Their detailed observations resulted in interpretations very close to our modern geologic maps prepared with modern techniques. Rocks and minerals are important resources.

Three Iowans won international recognition for their life-long study of local crinoid fossils. Their responsibility collecting and research enabled scientists around the world to learn of the remarkable fossils in the cliffs around Burlington and the quarries near Le Grand and Gilmore City.

Charles Wachsmuth came to Iowa from Germany in 1855. He often wandered the cliffs near his Burlington home, where he discovered crinoid deposits. Fascinated, he began to collect and study specimens

and he published his findings. Later, he was offered a position at Harvard University as an expert on crinoids. His wife, Bernadine Lorenz Wachsmuth, worked with him in collecting, researching, and writing about their discoveries.

Frank Springer became interested in paleontology as a law student at the University of Iowa. He established a law office in Burlington and began an association with the Wachsmuths, sharing their interests and collaborating on many publications. Even after he moved to New Mexico, Springer often returned to Burlington to continue his crinoid research.

Burnice H. Beane helped manage the family farm in Le Grand where as a boy he explored the LeGrand quarry and watched scientists excavate specimens. Two of these visitors were Frank Springer and Charles Wachsmuth. As an adult, Beane continued exploring the quarry, where workmen helped him collect thousands of specimens. His painstaking skill in preserving the crinoids resulted in an important scientific legacy. Many paleontologists and amateur collectors sought his advice and an opportunity to tour the famous quarry with the man who had become the guardian of its treasurers.

Crinoids were animals attached to the sea floor by flexible, rooted stalks. When they died, they usually broke loose and drifted away. The crinoid fossils found in the LeGrand quarry are remarkable because many of them were preserved nearly intact. The reason this happened is that nests of crinoids were rapidly buried in shallow depression that protected their bodies from currents. Lime-rich mud preserved their remains and hardened them into stone. The limestone slabs found near LeGrand contain fossilized crinoids and other sea animals in such abundance and detail that they have fascinated scientists around the world.

360 million years ago (in the Paleozoic era or Mississippian period) North America was located near the equator. Much of the land—including what's now Iowa—was submerged under shallow tropical seas. These warm waters teemed with countless creatures.

The inland seas reportedly swelled and retreated, alternately building up and exposing layers of sediments, sandwiching the remains of crinoids and other living things, and casting their impressions in stone.

Crinoids, commonly called "sea lilies" or "feather stars," belong to the echinoderm family (bodies covered with plates of calcite that form a skeletal structure) along with starfish, sand dollars, sea urchins, and sea cucumbers.

Some crinoid species crawled, some swam, and others attached themselves to rocks on the sea floor. They fed by means of cilia, located along grooves in their arms and branches, that brought tiny marine life to the mouth. Today, crinoids live in all the world's oceans, and where they're found, their abundant numbers and vibrant colors give the appearance of an underwater flower garden.

Animals get food directly from plants or other animals that eat plants. Crinoids are animals because they eat other marine life. Plants, on the other hand, make food by drawing energy from the sun and salts from water.

Crinoids have cup-shaped bodies with at least five feathery arms atop column sections that form cylinders and spirals. These shapes seem to radiate from a central point. This is called radial symmetry.

Fossils offer rare glimpses into our past. But many of these fragile artifacts face destruction each year from mining, construction, and erosion. In addition, private companies, individuals, museums, and universities all seek to unearth specimens to add to their collections. Laws protect many state and federal lands from the indiscriminate collecting of fossils. (Private lands are not covered by current or proposed laws.) The state of Iowa prohibits anyone from collecting fossils, stones, plants, and archeological material in parks, preserves, waterways, and lands owned by the state. There is a proposed federal law to limit collecting on federal lands to protect fossil resources.

Responsible professional and amateur collectors care for their specimens and record information about each one. Many collectors work with specialists from the Geological Survey, from universities and colleges, and form geological organizations to uncover more clues to our past. This cooperation and exchange of information contributes to our knowledge of Iowa.

Vocabulary:

Carbonized: all plants and animals, and some nonliving things, contain the element carbon, which sometimes remains after incomplete decay as hard black deposit.

Cast: when dead objects decay, they sometimes leave a cavity known as a natural mold. When this is filled by sand or clay or plaster, the cast duplicates the shape and surface of the fossil.

Concretion: hardened lumps of minerals deposited around seeds, shells, or rocks.

Coprolite: fossilized excrement that provides information about ancient creatures and their habits.

Crinoid: ("lily-like"): a group of marine animals also called sea lilies, belonging to the same family as starfish, sand dollars, sea urchins, and sea cucumbers. Certain crinoid species once thrived in Iowa's ancient seas.

Daemonelix ("devil's corkscrew"): a spiral-shaped fossil.

Echinoderm ("spiny-skinned"): marine animals with plates or spines that provide skeletal support. This group includes the crinoid and its relatives.

Erosion: the slow wearing away of the earth's surface, especially by wind, water, or glacial ice.

Fossil: the remains, impression, or trace of an animal or plant from a past geological age that has been preserved in the earth's crust.

Gastroliths: fossilized stones from the stomachs of animals, apparently swallowed to help grind and digest food.

Geology: the scientific study of the earth's surface and its physical features, especially rocks.

Index fossil: a fossil usually formed during a narrow period of time that is used to identify geologic formations on the surface and below the earth.

Invertebrate: animals without a spinal column

Matrix: the natural material in which a fossil, metal, gem, crystal, or pebble is embedded.

Mold: the impression or cavity left when a dead object decays or dissolves.

Paleontologist: a scientist who studies fossils and other ancient life forms form the geological past.

Petrified: a scientist who studies fossils and other ancient life forms from the geological past.

Pseudo-fossils: stones shaped by nature that resemble fossils.

Zoology: the science that studies animals and animal life.

Procedures:

1. Discuss what is "old." How can you tell something old from something new?

2. Talk about change. People change as they grow older. The environment changes too. Discuss changes in nature caused by flood, earthquakes, or erosion. How do human activities such as farming, mining, or building change the environment? Imagine all the different ways the landscape of Iowa has changed over millions of years.

3. Have students share their natural history collections, such as feathers, leaves, seeds, shells, rocks, or fossils. Display them in egg cartons or shoe boxes. Plastic magnifiers are useful for observing small objects. Make rubbings of different kinds of bark and leaves.

4. Have students—alone or in groups—gather objects, sort them, then label them. Make a nature notebook that includes notes and drawings.

5. Have students write a report on Iowa's official state rock, the geode. Why was it made the state rock? How are geodes formed and where are they found in Iowa? Bring a geode to class and crack it open with a small hammer. What does it look like inside?

Make Your Own Fossils

1. Flatten out clay and make an impression with your hand or press in flowers, leaves, or shells. Remove them carefully and let them dry.

2. Fill a container with soil mixed with some clay. Add water and stir until the mixture is thick and can be molded. Stir in small items—shells, pebbles, twigs, feathers, or leaves. Shape a mudpie that completely seals in some of these small items. Allow mudpies to dry completely. Before you break them open, have students discuss how they think the "fossils" will turn out. Break them open and then label them. Make rubbings or plaster casts of them.

3. Cover an object like a shell, a leaf or a chicken bone with petroleum jelly. Mix together 1/2 cup plaster of Paris and 1/4 cup water. Let the mixture set. Pour the plaster mix into an empty container—a pie plate or the bottom of a plastic milk jug. Press your greased object into the plaster. Dry for 24 hours. Remove the object. Cover the plaster with petroleum jelly and press clay over the mold. Then carefully remove the clay from the mold.

4. Put sand in different cups and stir in a few drops of different colors of tempera paint or food coloring. Let dry. Pour the colored sand into a large glass jar, alternating layers of different colors. Add small shells or pebbles along with the layers. Use a knife or stick to create valleys and mounds in the layers. Discuss how this model relates to Iowa's landscape.

Assessment of Outcomes:

Students will:

1. Gather objects and sort and label them to make a natural history collection or nature notebook for display in the classroom.

2. Explain to the class one or two interesting aspects about their collection or notebook with other class members.

Extensions and Adaptations:

1. Plan a trip across Iowa to see all the different geologic deposits. As a guide, use the geologic map of Iowa in Landforms of Iowa by Jean C. Prior or Iowa's Natural Heritage edited by Tom Cooper. With the help of these books, examine the locations of different deposits. Make a map showing your travels.

2. Make a display showing the different geological periods in Iowa history and what happened during the periods. Can you imagine what a million years is like? Can you imagine a million of anything? How would you depict the vast amounts of time involved in the history of life on earth?

3. Have students bring in rocks to examine and identify. Include among the "mystery minerals" quartz, hematite, talc, mica, calcite, graphite, and limestone. Use a rock and mineral field guide book as a reference. Number the samples, then analyze them for color, streaks, hardness, shine and weight. Spoon vinegar over them and see what happens (vinegar fizzes when it comes in contact with limestone and calcite.) After identifying the mineral samples, ask students what products the minerals can make. Examples: quartz/glass; hematite/red pigments in paints; tall cosmetics; calcite/natural cement; mica/paint; limestone/buildings.

4. Mineral Hardness Scale:
Very Soft: a fingernail scratches the mineral'
Soft: a penny scratches the mineral
Medium: a steel nail scratches the mineral
Hard: the mineral scratches glass

5. Ask students if they think the crinoid should be the official state fossil? If you think so, have them write a letter to a local legislator asking him or her to help you make it official.

Resources:

Recommended Reading

Cooper, Tom, Exec. Ed. *Iowa's Natural Heritage*. Iowa Natural Heritage Foundation and Iowa Academy of Science. Ames: Iowa State University Press, 1982.

Fenton, C.L. and M.A. Fenton. *The Fossil Book: A Record of Prehistoric Life*. Garden City, N.Y.: Doubleday & Co., Inc., 1959.

Iowa Dept. of Natural Resources, Geological Survey Bureau, 109

Trowbridge Hall, Iowa City, Iowa 52242-1319, 319–335-1575. Additional Education materials available upon request.

Prior, Jean C. "Fossils." *Iowa Geology 1993*, No. 18: pp. 14–19.

Prior, Jean C. *Landforms of Iowa*. Geological Survey Bureau. Iowa Dept. of Natural Resources. Iowa City: University of Iowa Press, 1991.

Prior, Jean C. "State Parks – Crossroads with the Geologic Past." *Iowa Geology 1989*, No. 14: pp. 9–13.

Witzke, Brian J. "Fossils: Evidence of Ancient Life in Iowa." *Iowa Geology 1983*, No. 8: pp. 4–9.

Witzke, Brain J. "Iowa's Ancient Seas." *Iowa Geology 1989*, No. 14: pp. 4–8.

Books & Articles: Primary-Intermediate Level

Allison, Linda. *The Sierra Club Summer Book*. San Francisco: Sierra Club Books, Little, Brown and Co., 1989.

Frankel, Lillian and Godfrey Frankel. *101 Best Nature Games and Projects.* New York: Sterling Publishing Co., 1959.

Kohl, Mary Ann F. and Cindy Gainer. *Good Earth Art, Environmental Art for Kids.* Bellingham, WA.: Bright Ring Pub., 1991.

Mathias, Marilynne W. and Robert A. Johnson. *Earth Below and Sky Above.* Syracuse N.Y.: New Readers Press, 1983.

Milord, Susan. *The Kid's Nature Book, 365 Indoor/Outdoor Activities and Experiences*. Charlotte, VT: Williamson Pub., 1989.

Ranger Rick's Naturescope: Diving Into Oceans. Geology — The Active Earth, National Wildlife Federation, 1412 16th St. N.W., Washington D.C. 20036–2266.

Riesser, Sharon and Linda Airey. "Will My Fossil Float?" *Science and Children,* 31 (Oct. 1993): pp. 42-43.

Rubin, Penni and Eleanora Robbins. *What's Under Your Feet? Earth Science For Everyone Activity Book.* U.S. Geological Survey (U.S. Dept. of Interior), Sup. of Documents, Washington D.C. 20402, 1992.

Schlenker, Richard M. and Sarah J. Yoshida. "Learning about Fossil Formation by Classroom Simulation." *Science Activities* 28 (Fall 1991): pp. 17–20.

Stein, Sara. *The Evolution Book.* New York: Workman Pub., 1986.

Van Deman, Barry A. "The Fall Collection." Science and Children 22 (Sept. 1994): pp. 20–21.

Books & Articles: Secondary Level-Adult

Anderson, Wayne I. *Geology of Iowa*. Ames: Iowa State University Press, 1983.

Brown, Vinson. *The Amateur Naturalist's Handbook*. Englewood, N.J.: Prentice-Hall, Inc., 1980.

Case, G.R. *A Pictorial Guide to Fossils*. New York: Van Nostrand Reinhold Co., 1982.

Gwynne, Charles S. "B.H. Beane and the LeGrand Crinoid Hunters." *Annals of Iowa* 35 (1961): pp. 481–485.

Hamblin, W. Kenneth. *The Earth's Dynamic Systems.* 4th Edition. Minneapolis: Burgess Pub., 1985.

Horick, Paul J. *Minerals of Iowa*. Iowa City: Iowa Geological Survey Educational Series II, 1974.

Norstrud, Karen Beane. "Crinoids in the Sugar Bowl: Remembering My Grandfather, Amateur Paleontologist B. H. Beane." *Palimpsest* 76 (Spring 1995).

Swaim, Ginalie. "Underwater Iowa — Where Graceful Crinoids Once Swayed in Ancient Seas." [photo essay] *Palimpsest* 76 (Spring 1995).

Troeger, Jack Clayton. *From Rift to Drift: Iowa's Story in Stone*. Ames: Iowa State University Press, 1983.

Wolf, Robert C. *Fossils of Iowa, Field Guide to Paleozoic Deposits*. Ames: Iowa State University Press, 1983.

(*Next to each resource below is the location where it can be found,- AEA stands for Area Education Agency, SL is the State Library*)

Film, Video: Primary-Intermediate

At Home on the Barrier Reef Video, 15 min., SL–VH12448, AEA–16413.

Life in a Tide Pool, Video, 13 min., AEA–19069.

Plant or Animal, Video, 15 min., SL–12768.

Rocks, Fossils and Earth History, Video, 16 min., AEA–52920.

Film, Video: Secondary-Adult

Building Bodies. (Marine Invertebrates). Video, 58 min., SLVH9650.

Earth: Discovering It's History. Video, 15 min., AEA–237.

Echinoderms: Sea Stars...Relatives. Film, 12 min., AEA-44219.

"The Little Sioux River, Pt. 1." (*Land Between Two Rivers*; fossils). Video, 30 min., AEA–5387.

Life Below. (Marine Life). Video, 15 min., AEA–17638.

Magic in the Rocks. (Fossils). Video, 38 min., SL–VH13109; 60 min., AEA–1908g.

Mysteries of the Hidden Reefs. (Marine Life). Film, 22 min., SL–M P3095.

Oceans. Video, 55 min., SL–VH9635.

Putting Flesh on Bones. (Fossils). Video, 36 min., SL–VH13110.

Rocks, Fossils and Earth History. Film, 16 min., SL-MP3057.